West Indies appears in the West Indian Bulletin, and the more technical work in *The Agricultural News*. Mr. F. W. South deals in a recent issue of the Bulletin with the control of scale insects by means of fungoid parasites. The fungi can be introduced in two ways: material containing fructifications may be hung on the tree near to the scale-infested part, or the fructifications may be stirred up with water, which is then sprayed on to the tree. When the spores germinate, the hyphæ grow under the scales and destroy the insects. In every issue of *The Agricultural News* a section is devoted to insect and fungoid pests; the diseases of rubber trees have recently received considerable attention. Some of the islands, as Jamaica and Trinidad, issue their own bulletins, in which the staff publications appear. In the Trinidad bulletin Mr. Rorer deals with pod-rot, canker, and chupon-wilt of cacao in a well-illustrated paper; spraying is shown to be effective, but definite instructions cannot yet be given owing to the absence of local experience of the treatment.

The Circulars and Agricultural Journal of the Royal Botanic Gardens, Ceylon, contain accounts, by T. Petch, of root diseases of Hevea and of *Acacia decurrens*, which is extensively planted as a wind-break in tea plantations and also for green manuring. The brown root disease, caused by *Hymenochaete noxia*, is the commonest root disease of Hevea in Ceylon, although this fungus does less damage than *Fomes semitostus*. *Sphaerostilbe repens* is also recorded, but is as yet not common. Two diseases of Acacia are described, one caused by an agaric, *Armillaria fuscipes*, the other by *Fomes australis*. A remarkable plague of a large snail, *Achatina fulica*, is described by E. E. Green, which swarms in millions in one area of the island. On the whole, it is considered to do more good than harm, as it feeds on animal and human excrement, and does comparatively little damage to the vegetation. Besides the circulars and journal, a series of leaflets are sent out from Ceylon.

Much of the Japanese work is published in the Journal of the College of Agriculture, Tokio, a beautifully illustrated periodical brought out in English and German. Vol. ii., No. 4, contains a paper by Ichiro Miyake on the fungi attacking rice. The list is, the author believes, complete, and as full references and descriptions are given, it must prove extremely valuable to other workers. It is in the true scientific spirit that the Japanese have broken down the barrier of language and issued their scientific publications in languages that can be read in the West.

In addition to the work going on at some of the larger agricultural colleges and departments in Great Britain, the smaller colleges are also studying the pests and diseases that occur in their districts. Mr. G. T. Malthouse recently, in a bulletin issued by the Harper-Adams Agricultural College, dealt with the wart disease of potatoes (*Chrysophlyctis endobiotica*), which has been doing much damage in Shropshire and Staffordshire. Accounts of the various diseases are also circulated as leaflets by the Board of Agriculture, as well as in their Journal.

TECHNICAL INSTRUCTION AND SECONDARY SCHOOLS.[1]

TECHNICAL instruction, in particular, has too long been looked upon as having little relation to the elementary or secondary schools. The schoolmaster has perhaps been too apt to view the technical school or college as an upstart and an interloper, the title of which to the name of an educational institution rests on a very insecure foundation, and the utilitarianism of which gives a somewhat unfair advantage in the competition for students. On the other hand, those engaged in technical work have in some cases looked upon the schoolmaster as an unpractical person, from whose clutches the student should be rescued at the earliest possible moment.

We have, however, now emerged from this stage, and are ready to discuss the relationships of our various schools with a better knowledge of the necessities and limitations of each, and taking as the basis the requirements of the scholar and not the supposed benefit to the school.

The scholar's work, from entering the elementary school to the end of his studentship, whenever that may be, should appear to him as an unbroken progress, during which he can see gradually unfolding a definite scheme leading eventually to his life's career. In so far as the various grades of education form a series of detached schemes without proper interrelationship, and to the extent to which the student's time is wasted when he passes from one grade to another by reason of this, to that degree our educational administration is defective, and we, as administrators, are lacking in skill or in our duty to the students and to the public. The solution of this problem proves to be very difficult, and even now the matter hardly receives the attention which it deserves. To provide in a sufficiently economical manner courses throughout the school suited to the different needs and capacities of various scholars is *the* educational problem. At what stage to introduce differentiation, and when to begin specialisation, and at what age a scholar should pass from one school to another—these are important but minor matters incidental to the main problem.

Keeping to the front the thought of the ultimate benefit of the student, and making this the determining factor, many details will settle themselves. Difficulties, of course, at once arise, due to the uncertainty or to differences of opinion as to whether a particular course of action is or is not for the benefit of the scholar. Here ideals will probably at once clash with practicabilities, and, as the head of a technical institution, I am perhaps predisposed to lay stress on the latter.

The problem presents itself to me in this form:—"How can we make the best use of the student's time up to the age when experience shows he will, in all probability, leave school, and what portion of this should be allocated to technical instruction?" Others may state it thus:—"In order to acquire a thoroughly trained intellect and well-stored mind, a student should pass from the elementary school at twelve or thirteen years of age to the secondary school, and should remain at the latter for at least four or five years. He cannot, therefore, enter a technical school under the age of seventeen or eighteen." How are we to reconcile these views?

Whilst it is, of course, true that all of us, men and women alike, and whatever our avocation, are of greater service, are more efficient, if we have received some training which may legitimately be termed "technical," we are not concerned with this general aspect of the subject on this occasion, but with that specialised technical instruction provided in the technical institutions. The students we wish to get in such institutions are those who will pass into the great industries of the country; and in investigating this matter we are at once confronted with the fundamental point that, of a thousand boys who pass through the elementary schools and who ultimately take positions as workmen, foremen, or managers in industrial concerns, probably not more than forty pass through a secondary school, and not more than three or four enter a day technical college. There is, therefore, a problem of enormous magnitude still requiring solution relative to the further instruction of the 950 out of every thousand boys who do not proceed beyond the elementary schools.

Before the advent of steam-driven machinery, when industrial conditions were much simpler, the personal instructions which the boys received under the apprenticeship system sufficed to produce the necessary skill and training, though in a very unequal degree. The personal association of the craftsmaster and the learner cannot, however, be relied upon under modern industrial conditions, and therefore the technical schools are called upon to provide a substitute for the apprenticeship system. Boys leaving the elementary schools are not, however, sufficiently mature to reap the full benefit of the advanced specialised instruction provided in day technical schools, and for these boys, most of whom will eventually become industrial operatives, I strongly advocate the establishment of what are known as trade preparatory schools, with a two years' course comprising, roughly, two-thirds general subjects and one-third handicraft work. The majority of the boys should then go to work and attend evening technical courses, but those who show special promise should be drafted into the day courses of the technical school by means of scholarships. A necessary and

[1] An address read to the Annual Congress of the Secondary Schools Association, held at Bradford on February 24, by Prof. Walter M. Gardner.

important link is thus formed between the elementary schools and the technical institutions, which link cannot be so efficiently provided by the evening continuation schools.

Such trade preparatory schools in no way interfere with the secondary schools. They simply provide for the further education of those boys who would not, in any event, go forward to the secondary schools. It is, however, obvious that the secondary schools must constitute the main feeder of the higher day technical courses, and it is this aspect of the general question with which we are chiefly concerned this afternoon.

With regard to the relationship between the secondary and technical schools, difficult and thorny questions at once crowd into the mind. At what age should the student pass from the secondary to the technical school? Should this age be the same, whatever the student's future career is likely to be? Should the secondary-school curriculum be the same for students who are going forward to a technical school as for those who are going into commerce or into one of the professions? If not, when should differentiation begin? Should any definite technical training (using the expression in the narrow sense of special training for industrial life) be given in the secondary school?

To not one of these inquiries can a categorical reply be given.

I am not at the present moment at all concerned with Government regulations as to age or curricula, but, looking at the age question purely from the point of view of the student's benefit, one cannot lose sight of the fact that the age at which the student should finally complete his school career depends on the nature of his future occupation; and this fact, coupled with the different requirements of various groups of students, in my opinion points strongly to the desirability, wherever numbers render it practicable, of differentiation in the secondary schools.

This raises the important question as to whether different groups of subjects may be made to yield similar educational results. If this is not so, differentiation must lapse; but many will probably agree that a study of science may be made as useful in developing intellectual capacity and character as an exclusive study of the humanities, and that as liberal an education may be got from literature and science as from entire devotion to languages, living or dead.

While speaking on this matter, I should further like to urge that education and culture, in the truest sense, may be acquired during the study of the processes involved in the transformation of raw materials into useful articles, which is the special business of the technical schools. The fact that present-day factory conditions are not perhaps conducive to the development of culture does not necessarily imply that educational ideals are inherently impossible in a technical school, but, on the other hand, emphasises the necessity of their development.

I argue, therefore, that a student's education, in the strictest sense of the word, is continued during a properly organised technical course, and must entirely dissent from the view that technical instruction is purely utilitarian.

We now come to close quarters with the question of the previous training desirable for students who will enter a technical college after passing through a secondary school.

May I point out in this connection that the value of the training in many secondary schools—speaking now of the information gained rather than the intellectual training—varies greatly according to the students' future work? If a lad is going to be a clerk, it so happens that most of the ordinary school subjects are such as will eventually form his tools in his trade of clerking. Of course, for higher commercial work he requires special instruction, but up to a certain point he receives his technical training incidentally along with the ordinary school training.

In the case of students who will enter the industries this does not hold good to anything approaching the same degree, and if it is possible to place these students on an equality in this respect by modifying the secondary-school curriculum, the gain to the technical schools will be enormous.

What, then, are the possibilities in this direction? With regard to the specialised technical work, I think nothing can be done. The importance of technical instruction being given by men having an intimate knowledge of the particular branch of industry concerned cannot be overrated, and such men are not likely to be found on the staffs of secondary schools, where, in fact, they would be out of place.

Manufacturing operations, and the technical instruction dealing with them, are, however, based on scientific fact, and mainly upon physical, mechanical, and chemical science, and a knowledge of these underlying sciences should precede the technical study of materials and processes. Men highly qualified to teach these sciences are, moreover, normally found on the staffs of secondary schools, and the teaching of physics, mechanics and chemistry, and of mathematics and art, might well be carried much further than is usually the case if it is done by the right men in the right way.

This, in my opinion, is the direction for advance. What we really need in the technical colleges are students with as much sound scientific training as possible—students trained to think for themselves and with the work habit highly developed. By economising time, this would enable us to carry students further forward, to the ultimate benefit of the industries of the country.

The whole matter is one which requires sympathetic consideration from both sides, and only in this way can any real advance be made. The teachers in the secondary and technical schools should be brought closer together, should have a more intimate knowledge of each other's work, and wherever practicable, as in a large city, the curriculum of at least one of the secondary schools should be so arranged as to offer to industrial students the same advantages as are now given in such generous measure to those who are training for commercial life or for the teaching and other professions.

CRYSTALLINE STRUCTURE, MINERAL, CHEMICAL, AND LIQUID.[1]

THE importance of crystallography has been growing so rapidly during recent years that the subject is no longer to be regarded merely as a branch of geology and mineralogy, but has now become a wide and far-reaching subject on its own account, embracing its former parent mineralogy, almost the whole of solid optics, the structure and physical properties, both mechanical and thermal, of solid matter, the structure and character of metals, with most important reference to their preparation for industrial application, and the fundamental groundwork of chemistry. Such a subject can no longer with impunity be relegated to a subsidiary part of a course in geology and mineralogy, but must in future be treated, studied, and taught as a specific branch of natural science. It is of the utmost urgency that all students of chemistry, physics, mineralogy, and metallurgy should be made acquainted with the main facts of the science in order that they may understand their own subjects with clear and broad insight.

It is a remarkable fact that no definition of life has yet been given which will not include a crystal. The virility and longevity of seeds and spores are often found to be quite extraordinary; but the power of crystalline growth goes even further, for it is everlasting. An instance was taken in the first lecture from common sand grains, which, originally quartz crystals in a granitic rock, after passing through every variety of vicissitude for thousands of years, when eventually they come in contact with water containing a little of their substance, silica, in solution, begin to grow again as crystals of quartz. A slide of such sand grains was shown on the screen, having perfect little quartz prisms and pyramids growing out from them.

Some fine examples of the growth of crystals were projected on the screen in polarised and ordinary light, notably of benzoic acid crystallising from the melted condition, of white arsenic crystals growing from the vaporous state, and of potassium bichromate and ammonium chloride growing from solutions of different degrees of supersaturation. Especial emphasis was laid on the fact that slow growth from the slightly supersaturated condition, that which has been so clearly defined

[1] Summary of three lectures delivered at the Royal Institution on February 28, March 7, and March 14, by Dr. A. E. H. Tutton, F.R.S.